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PACKAGE FOR CONTAINING LIGHT-EMITTING ELEMENT AND ITS MANUFACTURE
[Hakkō Soshi Shūnō-yō Pakkeiji oyobi sono Seizō·Hōhō]

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[Claims] /*

[Claim 1] A package for containing a light-emitting element made by stacking a ceramic sash provided with a through hole used to contain a light-emitting element on top of a ceramic substrate wherein a light-emitting element is mounted on the top surface, the invention characterized as a package used to contain a light-emitting element wherein the inside wall of the abovementioned through hole widens to the outside at an angle of 55 to 70° relative to the top surface of the abovementioned ceramic substrate and at the same time, the average surface roughness Ra in the center line on this surface is 1 to 3 μm and a metal layer wherein the reflectance of the light emitted from the abovementioned light-emitting element is at least 80 % is adhered.

[Claim 2] A method for manufacturing a package used to contain a light-emitting element characterized as including a process wherein a ceramic green sheet for a ceramic substrate and a ceramic green sheet for a ceramic sash are provided; next, a process wherein punching is carried out so that the inside wall of the through hole pierces the through hole used to contain the light-emitting element so that it has an inclined surface having an angle of 55 to 70° on the ceramic green sheet for the abovementioned ceramic sash; next, a process wherein a metalized paste is coated on the inside wall of the abovementioned through hole; next, a process wherein the ceramic

* Claim and paragraph numbers correspond to those in the foreign text.

green sheet for the abovementioned ceramic substrate and the ceramic green sheet for the abovementioned ceramic sash are bonded so that the inside wall of the abovementioned through hole widens toward the outside and at the same time, these are baked and the ceramic sash having the through hole used to contain the light-emitting element on the ceramic substrate becomes an integral piece with the laminate and at the same time, a sintered product is obtained having a metalized metal layer adhered to the inside wall of the abovementioned through hole; and next, a process wherein a plated metal layer having an average roughness Ra on the center line on the surface of the abovementioned metalized metal layer of 1 to 3 μm and having a reflectance of at least 80 % relative to the light emitted by the light-emitting element.

[Detailed Description of Invention]

[0001] [Technical Field]

The present invention relates to a package used to contain a light-emitting element used to contain a light-emitting diode and other light-emitting elements.

[0002] [Prior Art]

Ceramic packages used to contain light-emitting elements have conventionally been used as a package for containing light-emitting elements used to contain light-emitting diodes and other light-emitting elements.

[0003] As indicated in Figure 4, conventional ceramic packages used to contain light-emitting elements are made up of a roughly square plate-shaped ceramic substrate 31 provided with a mounting part 31a used to mount light-emitting element 35 in the center part on the top surface nd a pair of metalized wiring conductors 32 used to lead through to the bottom surface from this mounting part 31a and the area near it; and a roughly square bar-shaped ceramic sash 33 provided with a through hole 33a, laminated on the top surface of this ceramic substrate 31 used to contain light-emitting element 35 in the center part. Light-emitting element 35 is fixed to one of the metalized wiring conductors 32 led through to the top of mounted part 31a of ceramic substrate 31 through a conductive joining material and at the same time, connects electrically the electrode of the light-emitting element 35 and another metalized wiring conductor 32 via a bonding wire 36. Then, a transparent sealing resin (not shown in the figure) is packed into through hole 33a of ceramic sash 33, thereby providing a light-emitting device.

[0004] Furthermore, in this ceramic package used to contain a light-emitting element, a metalized metal layer 34 provided with a nickel plated layer and a gold plated layer on the surface is adhered to the inside wall of through hole 33a to provide good light emitting efficiency for the light-emitting device by reflecting light emitted by the light-emitting element stored inside through hole 33a.

[0005] Moreover, this type of packaging used to contain a light-emitting element is made by using the ceramic green sheet laminating method. Specifically, it is provided with a ceramic green sheet for ceramic substrate 31 and a ceramic green sheet for ceramic sash 33. At the same time, a through hole used to lead through a wiring conductor 32 on these ceramic green sheets and a through hole used to contain light-emitting element 35 are punched roughly vertically. Coating is carried out by using a metalized paste for metalized metal layer 34 on the inside wall of the through hole for the ceramic green sheet used for ceramic sash 33 using the conventional well-known screen printing method and the like. At the same time, the ceramic green sheet used for ceramic substrate 31 and the ceramic green sheet for the ceramic sash are stacked one on top of the other and bonded. Next, these are baked at a high temperature and they become sintered bodies. Then, a plated metal layer made up of nickel and gold · palladium · platinum and other metal is adhered to the exposed surface of metalized wiring conductor 32 and metalized metal layer 34 using the nonelectrolytic plating method and the electrolytic plating method.

[0006] [Problems Which the Present Invention is Intended to Solve]

However, when the conventional package for containing the light-emitting element was used, the inside wall of through hole 33a was roughly vertical relative to the upper surface of ceramic substrate 31. As a result, there were problems in that the light reflected on

the inside wall of through hole 33a was uniform on the outside part and was not released properly, and the light emitting efficiency of the light-emitting device using this package was not that high.

[0007] The present invention was proposed taking note of the problems associated with the conventional technique and it is an object of the present invention to provide a package for containing a light-emitting element which suitably reflects and diffuses light emitted by the light-emitting diode on the inside wall of the through hole used to contain this light-emitting element so that an extremely high light emitting efficiency is obtained for the light-emitting device.

[0008] [Means Used to Solve the Problems]

The package for containing a light-emitting element in the present invention is a package for containing a light-emitting element made by laminating a ceramic sash provided with a through hole used to contain the light-emitting element on the top surface of the roughly plate-shaped ceramic substrate provided with a mounting part used to mount the light-emitting element on the top surface, the invention characterized as follows. The inside wall of the through hole on the ceramic sash widens to the outside at an angle of 55 to 70° relative to the top surface of the ceramic substrate and at the same time, the average roughness Ra on the center line is 1 to 3 μm on the surface of this; a metal layer having a reflectance relative

to the light wherein the light-emitting element emits light is adhered.

[0009] Moreover, the method of manufacturing the package used to contain a light-emitting element in the present invention is characteristic in that it consists of a process wherein a ceramic green sheet used for the ceramic substrate and a ceramic green sheet for the ceramic sash are provided; next, a hole-punching process wherein a through hole used to contain a light-emitting element wherein the through hole used to contain the light-emitting element is pierced in the ceramic green sheet for the ceramic sash so that the inside wall is an inclined surface of 50 to 70°; next, a process wherein a metalized paste is coated on the inside wall of the through hole for the ceramic sash; next, a process wherein the ceramic green sheet for the abovementioned ceramic substrate and the ceramic green sheet for the abovementioned ceramic sash are bonded so that the inside wall of the abovementioned through hole widens toward the outside, and at the same time, these are baked and the ceramic sash having the through hole used to contain the light-emitting element on the ceramic substrate becomes an integral piece with the laminate and at the same time, a sintered product is obtained having a metalized metal layer adhered to the inside wall of the abovementioned through hole used to contain the light-emitting element; and next, a process wherein a plated metal layer wherein the center line average roughness Ra on the surface of the metalized metal layer on the

inside wall used to store the light-emitting element is 1 to 3 μm and the reflectance relative to the light emitted by the light emitting element is at least 80 %.

[0010] When the package used to contain the light-emitting element in the present invention is used, the inside wall of the through hole used to contain the light-emitting element in the present invention widens toward the outside at a 55° to 70° angle relative to the top surface of the ceramic substrate and at the same time, the average roughness Ra on the center line is 1 to 3 μm and a metal layer wherein the reflectance relative to the light emitted by the light-emitting element is at least 80 % is adhered. As a result, the light emitted by the light-emitting element contained inside the through hole is reflected and dispersed properly by the metal layer on the inside wall of the through hole which is at an incline and faces the outside and can be discharged properly.

[0011] Moreover, when the method of manufacturing the package used to contain the light-emitting element in the present invention is used, the inside wall pierces the through hole used to contain the light-emitting element on the ceramic green sheet used for the ceramic sash. Next, a metalized paste is coated onto the inside wall of the through hole used for this ceramic sash. Then, the ceramic green sheet for this ceramic sash and the ceramic green sheet for the ceramic substrate are bonded. At the same time, a sintered body is obtained wherein the metalized metal layer is adhered to the inside

wall of the through hole used to contain the light-emitting element. Next, a plated metal layer wherein the average roughness Ra of the center line on the surface of the metalized metal layer on the inside wall of the through hole used to contain the light-emitting element is 1 to 3 μm and the reflectance relative to the light emitted by the light-emitting element is at least 80 %. As a result, the light emitted by the light-emitting element contained inside the through hole is reflected and dispersed properly by the plated metal layer on the inside wall of the through hole which slants and is directed to the outside and discharged uniformly and efficiently.

[0012] [Mode of Working the Invention]

Next, we shall provide a detailed explanation of the package used to contain the light-emitting element in the present invention based on the attached figures. Figure 1 is a sectional view of an example of a mode of working the package used to contain the light-emitting diode in the present invention. 1 is the ceramic substrate; 2 is a ceramic sash; and the package used to contain the light-emitting element in the present invention used to contain the light-emitting element 3 is mainly configured of these.

[0013] Ceramic substrate 3 is a roughly square plate made up of an aluminum oxide substance sintered body and an aluminum nitride substance sintered body · murite substance sintered body · glass-ceramic and other ceramic materials; it functions as a support to

support light-emitting element 3 and is provided with a mounting part 1a used to mount light-emitting element 3 on the top surface.

[0014] Moreover, in ceramic substrate 1, the metalized wiring conductor 4a led through from the mounting part 1a to the bottom surface and metalized wiring conductor 4b led through from the periphery of mounting part 1a to the bottom surface are adhered and formed. Metalized wiring conductors 4a · 4b is made up of tungsten and molybdenum · copper · silver and other metal powder metalized substances and functions as a conductive pathway used to electrically connect light-emitting element 3 contained inside the package to the outside. Then, a light-emitting diode or other light-emitting element 3 is fixed by a metal-silicon alloy and silver-epoxy resin and other conductive joining material at a site on mounting part 1a of metalized wiring conductor 4a and at the same time, an electrode on light-emitting element 3 is electrically connected to the site around mounting part 1a of metalized wiring conductor 4b via a bonding wire 5.

[0015] Furthermore, when a metal having outstanding corrosion resistance of nickel and gold and the like on the surface exposed to metalized wiring conductors 4a · 4b is adhered to a thickness of approximately 1 to 20 μm, metalized wiring conductors 4a · 4b are effectively prevented from oxidizing and corroding. At the same time, the joining of metalized wiring conductor 4a and light-emitting element 3 and the joining of metalized wiring conductor 4b and

bonding wire 5 can be made so that they are sturdy. As a result, a nickel plated layer of approximately 1 to 10 μm and a gold plated layer of approximately 0.1 to 3 μm are successively adhered to the exposed surface of metalized wiring conductors 4a · 4b using the electrolytic plating method and the nonelectrolytic plating method.

[0016] On the other hand, ceramic sash 2 is made up of a ceramic substrate 1 and a ceramic material made essentially of the same composition, it is laminated on the top surface of ceramic substrate 1 and forms an integral piece. Ceramic sash 2 is provided with a roughly round and roughly four-cornered through hole 2a used to contain light-emitting element 3 at the center part and light emitting element 3 mounted on mounting part 1a inside this through hole 2a.

[0017] Moreover, metal layer 6 which covers a nickel and gold and other metal layer on the metalized metal layer made up of tungsten and molybdenum · copper · silver and other metal powder metallization is adhered roughly to the entire surface. Then, the plated metal layer on this metal layer 6 functions as a reflection member used to reflect and disperse the light emitted by light-emitting element 3 wherein the plated metal layer on this metal layer 6 is contained inside through hole 2a.

[0018] Furthermore, in the package used to contain the light-emitting element in the present invention, the inside wall of through hole 2a of ceramic sash 2 is formed so that it widens to the outside

at an angle θ of 55 to 70° relative to the top surface of ceramic substrate 1. The plated metal layer on the surface of metal layer 6 adhered to the inside wall of this through hole 2a is such that the average roughness Ra in the center line is 1 to 3 μm. Further, the reflectance relative to the light emitted by light-emitting element 3 contained inside through hole 2a is 80 % and above. Thus, the inside wall of through hole 2a on ceramic sash 2 is formed so that it widens to the outside at angle θ of 55 to 70° relative to the top surface of ceramic substrate 1. The average roughness Ra of the center line on the plated metal layer on the surface of metal layer 6 adhered to the inside wall of this through hole 2a is 1 to 3 μm. The reflectance relative to the light reflected relative to the light emitted by light-emitting element 3 contained inside through hole 2a is at least 80 %. As a result, the light emitted by light-emitting element 3 contained inside through hole 2a is reflected and dispersed properly on the surface of metal layer 6 of the inside wall of through hole 2a which is slanted and can be discharged uniformly and properly to the outside, thereby providing a light emission efficiency using this package which is extremely high.

[0019] Furthermore, when the inside wall of through hole 2a of ceramic sash 2 is such that angle θ which makes up the top surface exceeds 70°, it tends to be difficult for the light emitted by light-emitting element 3 contained inside through hole 2a to be properly reflected to the outside. On the other hand, when angle θ is less

than 55°, it tends to be difficult to stably and efficiently form the inside wall of through hole 2a at this angle. As a result, the angle θ formed by the inside wall of through hole 2a of ceramic sash 2 and the top surface of ceramic substrate 1 is specified within a range of 55 to 70°.

[0020] Moreover, when the plated metal layer on the surface of the metal layer which is adhered to the inside wall of through hole 2a is such that the average roughness Ra in the center line is less than 1 μm, the light emitted by light-emitting element 3 contained inside through hole 2a cannot be reflected and dispersed uniformly and a bias in the intensity of the light reflected tends to readily occur. On the other hand, when it exceeds 3 μm, it tends to be difficult to stably and efficiently form this type of rough surface. As a result, the average roughness Ra of the center line of the plated metal layer on the surface of metal layer 6 adhered to the inside wall of through hole 2a is specified within a range of 1 to 3 μm.

[0021] Further, the plated metal layer on the surface of metal layer 6 adhered to the inside wall of through hole 2a is such that when the reflectance relative to the light emitted by light-emitting element 3 contained inside through hole 2a is less than 80 %, it tends to be difficult to properly reflect the light emitted by light-emitting element 3 contained inside through hole 2a. As a result, the plated metal layer on the surface of metal layer 6 adhered to the

inside wall of through hole 2a is such that the reflectance relative to the light emitted by light-emitting element 3 contained inside through hole 2a is specified as at least 80 %.

[0022] Moreover, when through hole 2a has a roughly round shape, the light emitted by light-emitting element 3 contained inside through hole 2a is reflected evenly in all directions on the inside wall of roughly round through hole 2a and can be discharged to the outside so that it is extremely even. As a result, through hole 2a should be shaped so that it is roughly round.

[0023] Thus, when the package for containing the light-emitting element in the present invention is used, light-emitting element 3 is mounted on metalized wiring conductor 4a on top of mounting part 1a of ceramic substrate 1 and the electrode of the light-emitting element and the metalized wired conductor 4b are connected electrically via the bonding wire. Then, a transparent sealing resin is packed inside through hole 2a in which light-emitting element 3 is contained and light-emitting element 3 is sealed in, thereby providing a light-emitting device.

[0024] Next, we shall describe the method of manufacturing the package used to contain the light-emitting element in the present invention based on the attached drawings. Figure 2 (a) through (d) is a sectional view of each of the processes involved in the method used to manufacture the package used to contain the light-emitting element in the present invention.

[0025] First, as indicated in Figure 2 (a), ceramic green sheet 11 for ceramic substrate 1 and ceramic green sheet 12 for ceramic sash 2 are prepared.

[0026] If these ceramic green sheets 11 and 12 are such that ceramic substrate 1 and ceramic sash 2 are made up of an aluminum oxide substance sintered body, a suitable organic binder and solvent · plasticizer · dispersant and the like are added to a ceramic raw material powder made of aluminum oxide · silicon oxide · calcium oxide · magnesium oxide and the like and mixed together and form a slurry. At the same time, a well-known sheet-forming technique such as the doctor blade method and the like are used to provide a sheet formed of a prescribed thickness.

[0027] Next, a through hole 11a used as the lead-through pathway to lead the metalized wiring conductors 4a · 4b through from the top surface of ceramic substrate 1 to the bottom surface is punched on ceramic green sheet 11 used for a ceramic substrate using a punch metal die. At the same time, a through hole 12a used for through hole 2a is punched on ceramic green sheet for ceramic sash 2 using a punching metal die as indicated in Figure 2 (b).

[0028] At this time, the inside wall of through hole 12a formed on ceramic green sheet 12 used for ceramic sash 2 is formed so that it widens at angle θ of 55 to 70° from the main surface of one of the ceramic green sheets 12 to the main surface of the other green sheet. Thus, the inside wall of through hole 12a is formed so that it widens

at angle θ at 55 to 70° from the main surface of ceramic green sheet 12 toward the main surface of the other green sheet. As a result, the inside wall of through hole 2a of ceramic sash 2 is formed so that it widens outward to the outside at angle θ of 55 to 70° relative to the top surface of ceramic substrate 1.

[0029] Thus, when the inside wall of through hole 2a is formed so that it widens at angle θ of 55 to 70° relative to the top surface of the ceramic substrate from the main surface of one of ceramic green sheets 12 to the main surface of the other green sheet, the clearance between punching metal die punch 21 and die 22 should be set so that it is wide, as indicated in the sectional view used to explain the method of punching out through hole 12 in Figure 3. For example, if ceramic green sheet 12 is approximately 0.5 mm thick, the clearance C for the metal die should be set so that it is approximately 0.2 to 0.5 mm, thereby making it possible to use an angle θ of 55 to 70°. Furthermore, when angle θ is less than 55°, it tends to be difficult to form the inside wall of through hole 12a at angle θ stably and efficiently.

[0030] Thus, the clearance C of the punching metal die is set so that it is wide and the roughness of the inside wall of through hole 12a used to punch out the ceramic green sheet 12 is considerably prominent. Then, the average roughness Ra of the center line of the inside wall of through hole 2a for the package used to contain the light-emitting element obtained in this way is extremely rough at

approximately 4 to 10 μm. Therefore, the average roughness of the center line of metal layer 6 adhered to the inside wall of this through hole 2a can have a roughness of approximately 1 to 3 μm.

[0031] Next, as indicated in Figure 2 (c), metalized paste 14a · 14b of metalized wiring conductors 4a · 4b is used for screen printing inside the top and bottom surface of ceramic green sheet 11 of ceramic substrate 1 and inside through hole 11a and printing and coating are carried out to a prescribed pattern. At the same time, metalized paste 16 for metal layer 6 is likewise printed and coated onto the inside wall of through hole 12a of the ceramic green sheet for ceramic sash 2 using the screen printing method. Furthermore, when coating on metalizing paste 14a · 14b and 16 inside through hole 11a and the inside wall of through hole 12a is carried out, a method is used which involves printing while suctioning metalized paste 14a · 14b and 16 from the opposite side of the printed surfaces. At this time, the viscosity of metalized paste 16 is made so that it is approximately 30 to 200 Pa·S and at the same time, printing is carried out so that it is approximately 10 to 25 μm. As a result, the average roughness Ra in the center line of the surface of metal layer 6 of the package used to contain the light-emitting element may be made approximately 1 to 3 μm.

[0032] Next, as indicated in Figure 2 (d), ceramic green sheet 12 used for ceramic sash 2 is bonded to the top surface of ceramic green sheet 11 used for ceramic substrate 1 so that the inside wall of

through hole 12a widens outward. This bonding process involves coating on a bonding agent containing an organic binder and a solvent on the bottom surface of ceramic green sheet 12. At the same time, a method should be used which involves stacking this ceramic green sheet 12 on the top surface of ceramic green sheet 11 and crimping while heating at a temperature of approximately 40 to 60°C at a pressure of 2 to 6 MPa.

[0033] Last of all, a sintered body is obtained wherein ceramic substrate 1 and ceramic sash 2 which have been laminated are sintered and form an integral piece by baking ceramic green sheets 11 · 12 and the metalized paste 14 coated on these at a high temperature. At the same time, by adhering nickel and gold · platinum · palladium and other plated metal layers using the electrolytic plating method and the nonelectrolytic plating method on the surface exposed on the conductive part of this sintered body, the package used to contain the light-emitting element indicating in Figure 1 is completed.

[0034] Furthermore, at this time, metal layer 6 is such that average roughness Ra of the center line in the plated metal layer on the surface is made 1 to 3 μm and at the same time, the reflectance on the plated metal layer relative to the light emitted by light-emitting element 3 is made at least 80 %. The average roughness of the center line Ra on the plated metal layer of the surface of metal layer 6 is made 1 to 3 μm. At the same time, when making the

reflectance of the plated metal layer relative to the light emitted from light-emitting element 3 at least 80 %, the average roughness Ra of the center line of the metalized metal layer on metal layer 6 is made 3 to 6 μm. At the same time, a plated metal layer which is 1 to 13 μm thick is adhered to the surface of the metalized metal layer.

[0035] When the package used to contain the light-emitting element in the present invention is used, the inside wall of through hole 2a used to contain light-emitting element 3 widens outward at an angle of 55 to 70° relative to the top surface of ceramic substrate 1; at the same time, the average roughness Ra of the center line on the surface of this inside wall is 1 to 3 μm and a metal layer having a reflectance relative to the light emitted from light-emitting element 3 of at least 80 % is adhered.

[0036] Furthermore, the present invention is by no means restricted to the abovementioned modes of working the invention and needless to say, a variety of modifications may be carried out.

[0037] [Effect of Invention]

The package used to contain the light-emitting element in the present invention is such that the inside wall of the through hole used to contain the light-emitting element widens outward at an angle of 55 to 70° relative to the top surface of the ceramic substrate. At the same time, average roughness Ra on the center line on the surface of the inside wall is 1 to 3 μm and a metal layer is adhered wherein the reflectance of the light emitted by the light-emitting element is

at least 80 %. As a result, the light emitted by the light-emitting element contained in the through hole can be reflected and dispersed properly by the metal layer on the inside wall of the slanting through hole towards the outside and discharged evenly and efficiently. As a result, the light-emitting efficiency of the light-emitting device which uses this package for containing the light-emitting element can be made extremely high.

[0038] Moreover, when the method for manufacturing the package for containing a light-emitting element in the present invention is used, the through hole used to contain the light-emitting element is pierced on the ceramic green sheet for the ceramic sash so that the inside wall has an inclined surface of 55 to 70°. Next, the metalized paste is coated onto the inside wall of the through hole used for this ceramic sash. The ceramic green sheet for this ceramic sash and the ceramic green sheet for the ceramic substrate are bonded so that the inside wall of the through hole of the ceramic green sheet for the ceramic sash widens outward. At the same time, these are baked and the ceramic sash provided with the through hole used to contain the light-emitting element is laminated on the ceramic substrate so that they are laminated and form an integral piece. At the same time, a sintered product can be obtained whereby a metalized metal layer is adhered on the inside wall of the through hole used to contain the light-emitting element. Next, a plated metal layer wherein the average surface roughness Ra on the center line on the surface of the

metalized metal layer on the inside wall of the through hole used to contain the light-emitting element is 1 to 3 μm and the reflectance relative to the light emitted by the light-emitting element is at least 80 %. As a result, the light emitted by the light-emitting element contained inside the through hole can be reflected and dispersed properly from the plated metal layer on the inside wall of the through hole which is slanted to the outside, thereby providing a package for containing a light-emitting element which can be discharged uniformly and efficiently.

[Brief Explanation of Figures]

[Figure 1] A sectional view of a mode of working the package used to contain the light-emitting element in the present invention.

[Figure 2] A sectional view of each of the processes involved to explain the method of manufacturing in the present invention used to manufacture the package used to contain the light-emitting element in the present invention.

[Figure 3] A sectional view of the method of punching out the ceramic green sheet in the manufacturing method in the present invention.

[Figure 4] A sectional view of the conventional package used to contain the light-emitting element.

[Explanation of Notation]

1 … ceramic substrate

1a … mounting part

2 … ceramic sash

2a … through hole used to contain light-emitting element 3

3 … light-emitting element

6 … metal layer

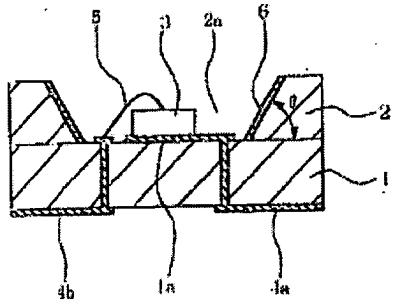
11 … ceramic green sheet for ceramic substrate 1

12 … ceramic green sheet for ceramic sash 2

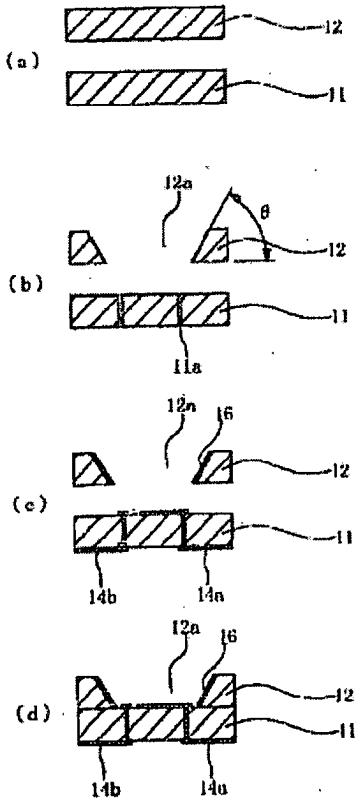
12a … through hole for through hole 2a

16 … metalized paste

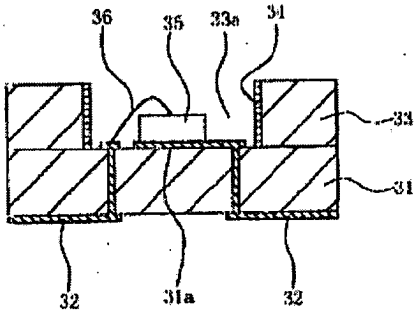
[Figure 1]



[Figure 2]



[Figure 4]



[Figure 3]